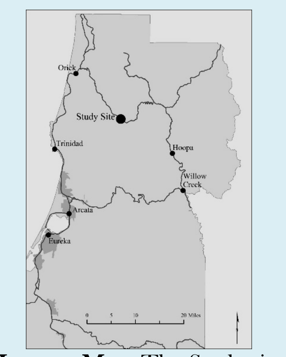
Preparation Of High Spatial And Temporal Resolution Data For GIS Applications

Abstract

High resolution aerial imagery has, until now, been expensive to capture. Costs include the operation of satellites and manned aircraft, high-quality imaging systems, and the post-processing necessary to transform photographs into carefully corrected data. Current sUAS technology offers an affordable means to acquiring data of the highest spatial and temporal resolutions.



Locator Map: The Study site was located at the Bald Hills in Humboldt County, CA

Introduction

Unmanned Aircraft Systems (UAS) or Unmanned Aerial Vehicles (UAV) are aircraft operated remotely through radio signals. Like manned aircraft, some are built with fixed wings and others achieve lift using rotors, like helicopters do. Finding their origins among recreationists, they are now being fitted with new, lightweight, high-resolution digital cameras to capture aerial imagery. Aerial imagery has, until now, been expensive to capture. Costs include operation of aircraft, high-quality cameras, and the post-processing necessary to turn photographs into carefully corrected data. SUAS offer a much cheaper way to obtain high-quality, pertinent data (Rango et al. 2006). With the ability to capture images of the highest spatial and temporal resolutions, these small aircraft have the potential to allow researchers to collect the data they need to answer questions at much lower costs than previously feasible.

Methods

Aerial Images. For this study, we explored various methods for post-processing aerial images. Our aim was to explore methods that can be utilized on image datasets acquired with a sUAS. Our tests were conducted on 2014 NAIP 1-meter imagery. To test ArcMap's ability to create a mosaic, we clipped a NAIP image of our study area into a subset of 4 images. We then used the "Mosaic to New Raster" tool in ArcMap to stitch the images together.

Ground Control Points. We established 10 ground control points (GCPs) across our study area. The GCPs were created from 12 in records that were painted white to improve reflectivity. We positioned the GCPs along a centerline for the site, and halfway between the centerline and the perimeter. We used a Trimble Geoexplorer 6000 to record the latitude, longitude, and elevation of each GCP. The data was converted to a shapefile in Trimble's Pathfinder Office, and then imported into ArcMap and overlaid on our NAIP mosaic. While NAIP images are georeferenced, images acquired with a sUAS are often not. In this case, we could use the GCP shapefile to georeference a mosaic create from sUAS data.

Streams. We traced the headwaters of the study site with the Trimble Geoexplorer 6000. This data was converted to a shapefile in Pathfinder Office, imported into ArcMap, and overlaid on the NAIP mosaic.

Supervised Classification. We performed a supervised classification on the NAIP mosaic to isolate grassland areas for the study site. We used ArcMap's supervised classification tool to perform this operation. While the tool effectively identifies vegetation classes, the 1-meter spatial resolution of NAIP imagery does not compare to the resolution of sUAS acquired images, which can be less than 2 centimeters. A classification performed on data of this resolution can provide significantly more information.

Time-lapse. We acquired images of the study area for the years 1947, 1976, and 2014. These images provide for an evaluation of land cover change over the past 68 years. Currently, NAIP images area acquired on a 3-year cycle. sUAS can be used to monitor a site multiple times a day, at virtually no cost, allowing researches to monitor the subtlest changes in environmental conditions.

Results

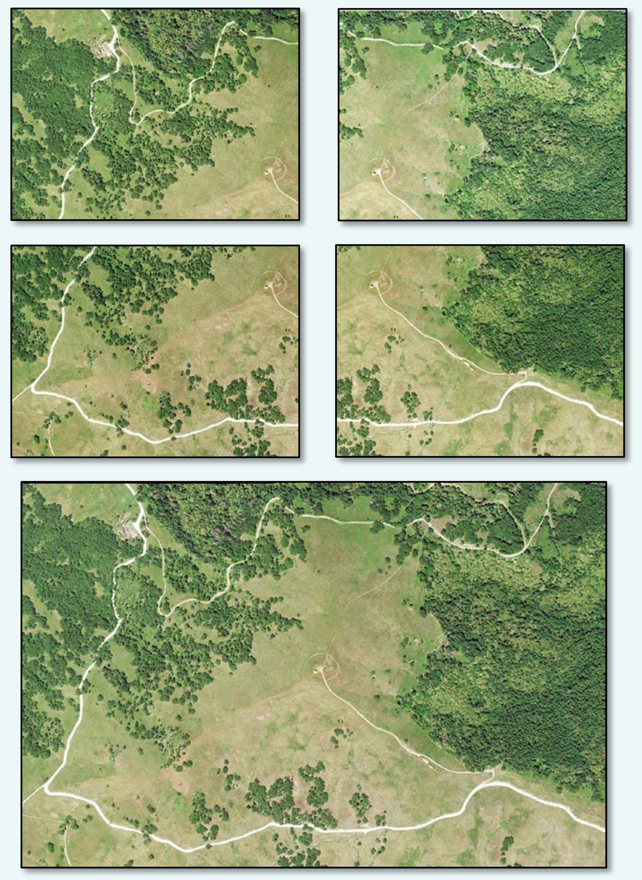


Figure 1. Images captured with a sUAS can be stitched together into high-resolution mosaics.

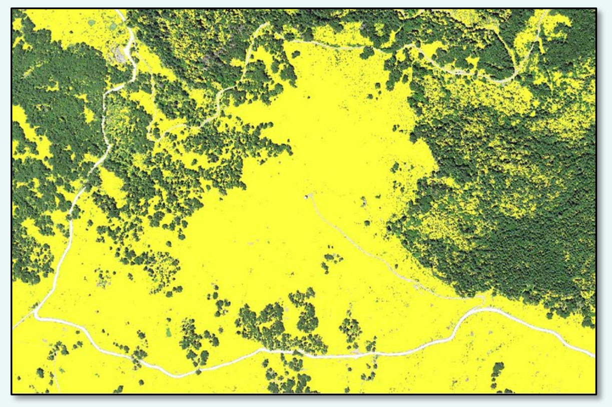


Figure 2. Grassland area for the study site. The area was obtained by running a supervised classification on the mosaic. Total grassland area for the site is approximately, 124.7304 ha. Please note that this classification is not perfect. Some areas of forest were misclassified as grassland.

Figure 3. Headwaters located in the study site. Data was collected with a Trimble Geoexplorer 6000.

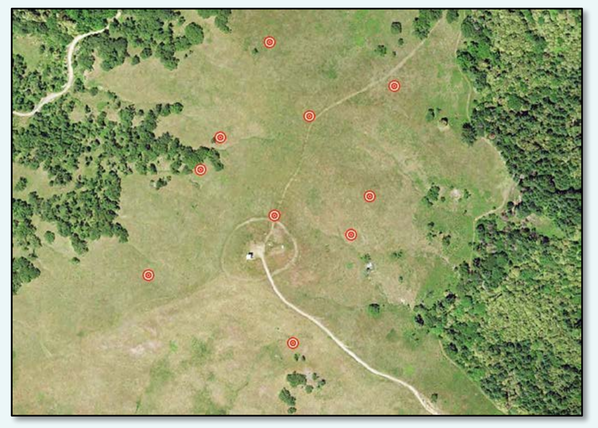


Figure 4. Ground control points for the study area. Data was collected with a Trimble Geoexplorer 6000.

Ground Control Points. Both a base station and USGS bench mark were located on the study site. The base station enabled us to achieve very high accuracy through a differential correction on the GCPs. 97.81% of corrected positions were corrected to within 5-15 centimeters. The bench mark elevation was 3097 feet. The height of one of our GCPs, which we placed beside the benchmark, was identified as 3097.11 feet by our Trimble Geoexplorer 6000. Figure 4 shows the ground control points.

Streams. In mapping out streams within the study area, we found the Trimble Geoexplorer 6000 data to be extremely accurate. The streams in the shapefile appeared to align accurately with their respective locations in the NAIP mosaic, seen in figure 3.

Supervised Classification. Total grassland area for the site is approximately, 124.7304 ha. It is important to note that some areas of forest were misclassified as grassland. See figure 2.

Time-lapse. Comparison of aerial photographs, figure 5, for the study area for the time period beginning in 1947 and ending in 2014 reveals changes in the distribution of conifer, oak, and grasslands. The most significant change appears north-east of the lookout tower, where conifers have encroached significantly into the grassland area. This is clearly discernable in the 1976 and 2014 images.

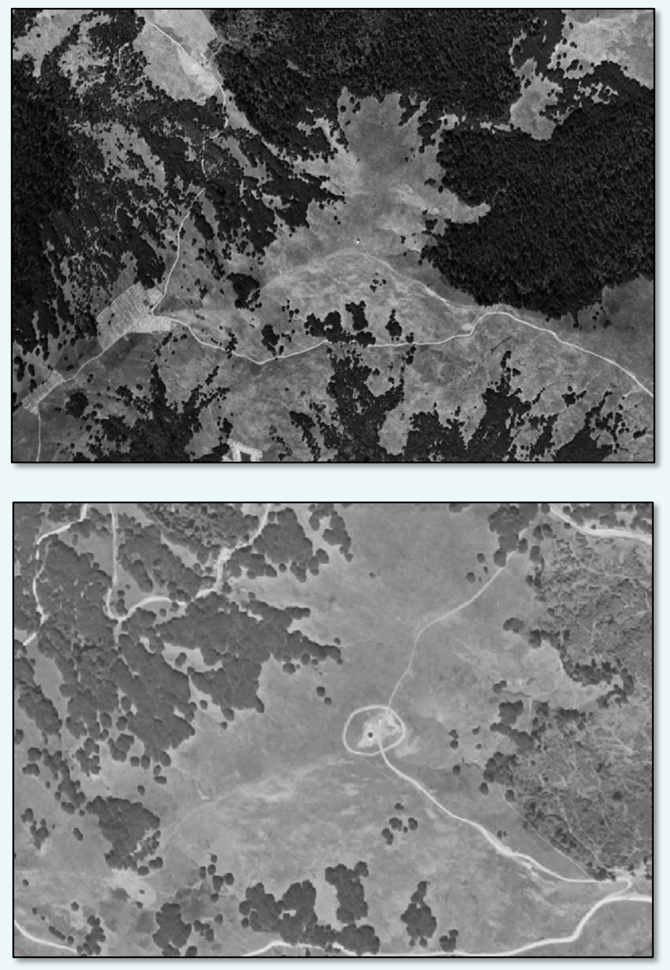


Figure 5. Time lapse photos of the study site: From top to bottom and left to right: 1947, 1976, and 2014

Group photo on the study site. From left to right: Chris Muhl, Alexa Dejoannis , Whitney Newcomb and Kris Anderson

Creating Ground Control Points. From left to right: Whitney Newcomb, Kristy Points, Priscilla Baltezar, Chris Muhl, and Dylan Hills

USGS Geological Survey Marker found on study site

Lookout tower located at study site

Group Members from left to right: Chris Muhl, Kris Anderson, and Whitney Newcomb, at a vernal pool located on the study site.

Images of the Bald Hills

Conclusion

We explored various post-processing techniques with aerial images, with the aim of refining methods for utilizing data acquired with a sUAS. We used 1-meter NAIP images to perform our evaluation, and integrated mobile mapping techniques to enhance our dataset.

Our method for establishing ground control points was extremely effective. Our results suggest that this approach would be an effective means for georeferencing aerial images acquired with a sUAS. After applying a differential correction, 97.81% of corrected positions were corrected to within 5-15 centimeters.

We believe that there is enormous potential for using sUAS images for defining vegetation classifications. Ultra-high resolution data will provide the opportunity to map vegetation distribution at the finest scale.

The temporal resolution of sUAS provides the possibility to monitor land cover change in near-real-time. While temporal resolution of the NAIP imagery we used is suitable for many applications, there are certainly situations in which higher temporal resolution is needed. Specifically, sUAS images could provide more precise data on conifer encroachment.

Completed by Chris Muhl, Alexa Dejoannis , Kris Anderson, Whitney Newcomb, and Dylan Hills.

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Works cited: Rango, A., A. Laliberte, C. Steele, J. E. Herrick, B. Bestelmeyer, T. Schmugge, A.Roanhorse, and V. Jenkins. 2006. Using unmanned aerial vehicles for rangelands: Current applications and future potentials. Environmental Practice 8:159-168.

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